# Nakamichi

## ZX-9 Discrete Head Cassette Deck

# Direct Drive With A Difference

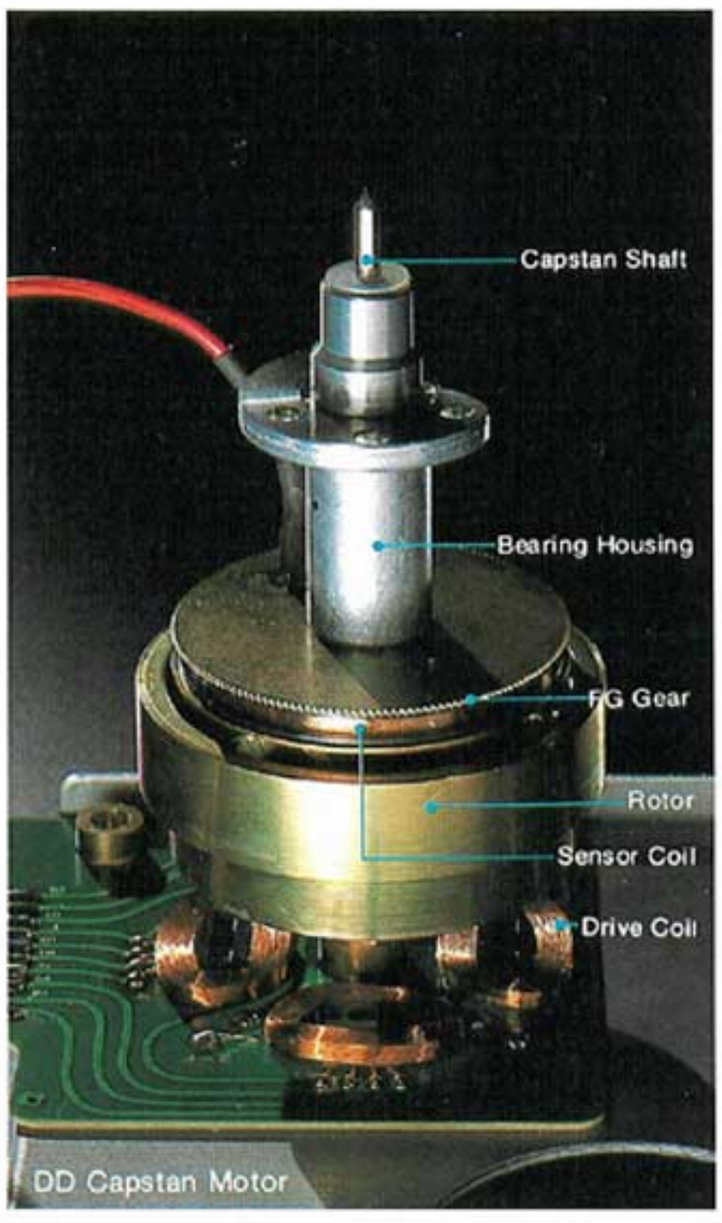
## Direct Drive Often Creates More Problems Than It Solves, The Nakamichi Super Linear Torque DD Motor Makes Flutterless Direct Drive Possible.

**Traditionally, Nakamichi cassette decks have been belt driven, Why have we changed?**
Creativity never justifies arbitrary abandonment of old principles. Before change, the virtues and drawbacks of old and new must be analyzed and balanced against each other. For example, many discriminating audiophiles prefer "old-style" belt-driven turntables to the new "direct drives," Why? Because a belt-driven turntable often *sounds* better, but specifications do not suggest the reason!

**Why does belt-drive sound so good?**
To answer this, we must understand the problems of a direct-drive motor and why "good specs" are not always synonymous with "good sound."

As a motor turns, its rotor "cogs" or steps from magnetic pole to magnetic pole forced by a varying magnetic field. In a belt-driven system, these instantaneous speed variations are "filtered" by the belt which stretches and contracts microscopically and absorbs speed variations too rapid for the flywheel to follow. In a directly driven system, motor cogging affects tape motion directly.

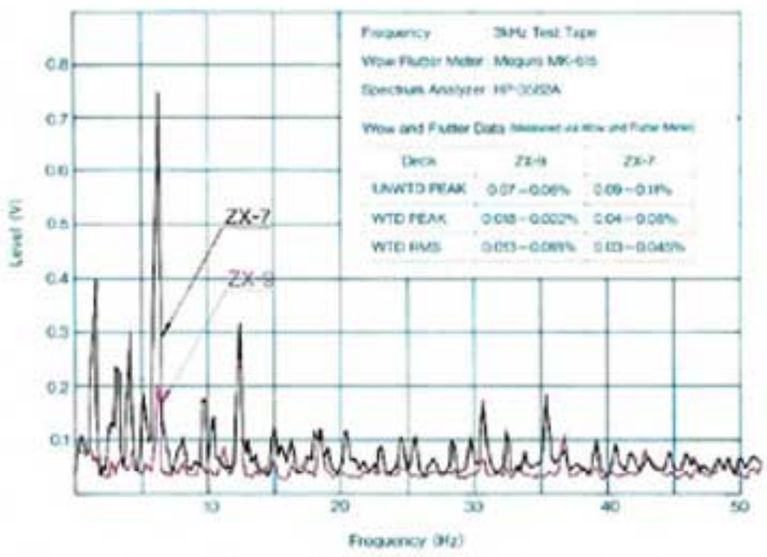
**Isn't cogging included in flutter specs?**
No! "Weighted flutter" is measured with a filter that corrects for human sensitivity to *pitch* variation but not really to flutter. Slow changes in pitch are readily discernible, especially those that occur about 4 times a second; the curve weights these very heavily.



DD Capstan Motor

Rapid speed changes flutter are not heard as a change in *pitch* but rather as a muddy lack of clarity. These changes, which affect direct-drive systems more than belt-driven ones, are suppressed in weighted measurements; "wow," the problem with belt-drive, is heavily accounted. Thus, one can have "good specs and bad sound!"

**Is belt drive the best solution?**
Not necessarily. Theoretically, direct drive produces less wow, and, if motor cogging is eliminated, it will produce the most perfect motion. Nakamichi is open to any approach that will improve quality, but we will not adopt one that sacrifices *sound* for "specifications." We realized the problem with direct drive at a very early stage and avoided using it until we found a solution!



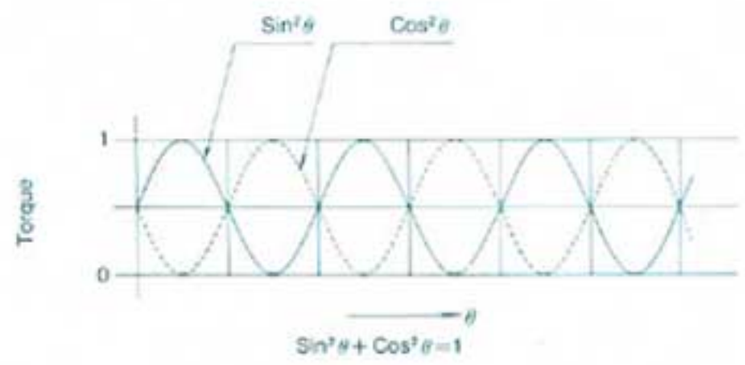
Flutter Spectral Analysis (UNWTD Peak)

**How was the direct-drive problem solved?**
By focusing on the problem at its source and developing a new motor that produces absolutely uniform torque *throughout* each revolution. We call it the "Super Linear Torque" motor; it appeared first in our TX-1000 turntable and now makes its cassette-recorder debut in the ZX-9.

A motor operates on the repulsive force between like magnetic poles. In the simplest case, a magnet, free to rotate about its axis, is suspended near a set of coils. Current through the coils creates an electromagnetic field that interacts with the magnet's field and causes the magnet to move.

The torque depends upon the strength of the two fields and the angle between them. For given field strengths, torque is greatest when the fields are perpendicular and zero when they are aligned. If the direction of the current is switched as the magnet passes through the zero force point, inertia carries the rotor beyond that point, and it continues to rotate.

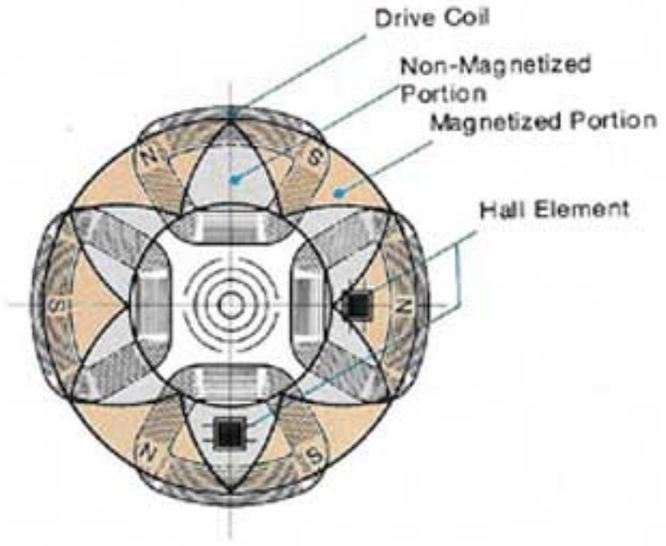
But the force is never constant; it varies with the instantaneous angular relationship between the rotor and the coils. Thus torque varies throughout each revolution and the motor "cogs." Increasing the number of coils and poles reduces cogging because the total torque is the sum of those generated by each coil-pole pair. But cogging cannot be eliminated entirely with traditional construction.



Rotor Rotation Angle and Torque Relationship

Nakamichi's solution to this dilemma was to create a special star-shaped magnetic pattern on the rotor that produces a sinusoidal variation of north and south strength about the circumference. Two sets of coils are fed with a 2-phase sinusoidal electrical signal. The torque developed by one set is proportional to the $\sin^2$ of the angle of rotation; the torque developed by the second set is proportional to the $\cos^2$. Since total torque is equal to the sum and $\sin^2 + \cos^2 = 1$, torque is constant at all rotation angles, and the motor doesn't cog - a solution elegant in its simplicity (but one it took us some time to come up with!)

Although it is not easy to reduce the wow and flutter of a well designed dual-capstan transport — especially one that utilizes the Asymmetrical. Diffused-Resonance principle created by Nakamichi — the Super Linear Torque DD Motor does do so, ZX-9 flutter is a remarkable 0.022% WRMS, and, as the chart shows, not only is wow virtually eliminated, but high-frequency flutter is less too!



Rotor Magnetic Pattern and Coil Relationship

# Complete Tape-Calibration Facilities

## Realize The Full Potential Of Every Cassette With Individual Calibration Of Bias, Sensitivity, And Recording Azimuth.

**Are over a dozen calibration controls really necessary for good sound?**

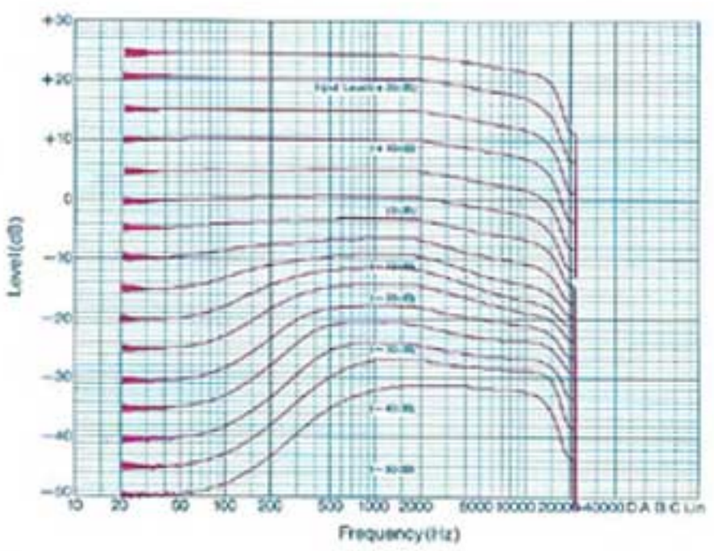
No, not for "good" sound. But for perfect sound, they are! Although phono cartridges and loudspeakers may have a characteristic sound, a cassette recorder shouldn't. What we mean by "Nakamichi Sound" is *accurate* sound — free from response aberrations, tape hiss, modulation noise, flutter, etc. that diminish reproduction accuracy. Such perfection requires extraordinarily good heads, electronics, mechanisms *and* precise tape matching. The ZX-9 was designed for the discriminating audiophile satisfied with nothing less than perfection and willing to spend a moment adjusting the deck to achieve it.

Differences exist among brands of tape — even from batch to batch of the same brand. A C-60 may not have precisely the same characteristics as a C-90, and there can even be differences between left and right channels. To compensate for these and provide the ZX-9 owner with freedom of choice, we have included an extensive array of calibration facilities.

**Are these adjustments required to take full advantage of Dolby-C NR?**

Yes, indeed! Dolby-C NR is truly remarkable, but it works best only when conditions are properly arranged. When Dolby-B NR was introduced, some audiophiles felt it changed sound quality. The fault did not lie with the Dolby system but with those recorders incapable of using it. As decks improved, criticism disappeared. The present situation with Dolby-C NR is similar. C-type NR uses twice the compression and expansion of B-type NR, and even small response errors are magnified. To take full advantage of Dolby-C NR *without changing sound character*, the deck must be virtually perfect to begin with.

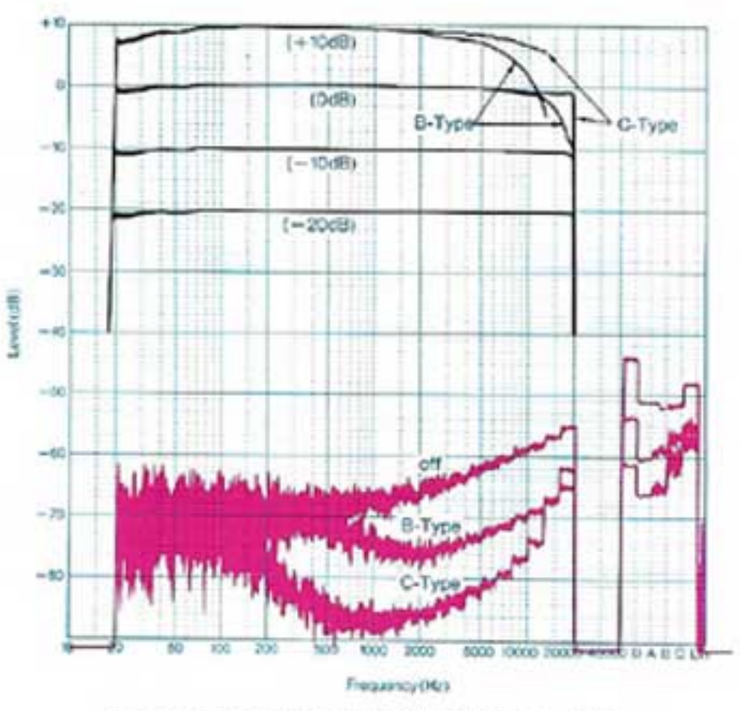
If bias is too high for the tape, treble response diminishes; Dolby-C NR then acts to reduce it further. If azimuth is slightly off, high-frequency response is impaired, and the Dolby circuitry exaggerates the error further. Thus, the ZX-9 is provided with bias and azimuth calibration controls to ensure perfectly flat response *prior* to Dolby application.




C-Type Encode Characteristics
(Level vs. Frequency)

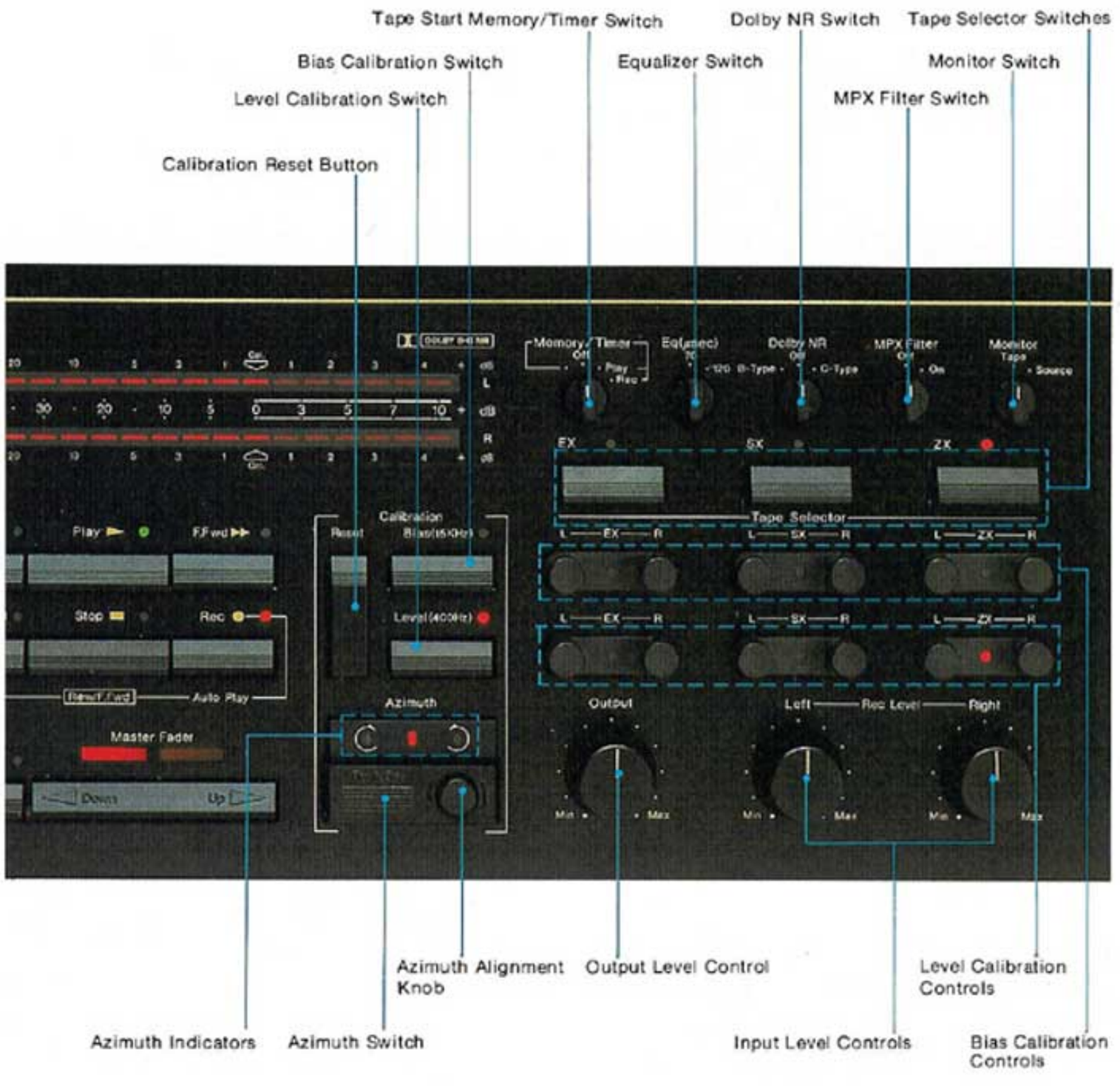
Maintaining the correct reference between encode and decode circuitry is most important. Differences in tape sensitivity affect tracking accuracy. If a tape's sensitivity is 2-dB lower than "standard," signals play back 2-dB lower in level. The Dolby decoder thinks these signals were softer to begin with and therefore compressed more than they have been. It decodes them with a different curve than that used for encoding, resulting in a noticeable change in frequency response. So, the ZX-9 has level calibration controls to compensate for differences in tape sensitivity and ensure perfect Dolby tracking.

Differences may exist between left and right channels, so separate controls are provided for each. The ZX-9 has separate sets of controls for each type tape so you can calibrate for your favorite brand of each and not have to recalibrate until you change brands or batch numbers. For best results, azimuth should be aligned on every cassette. This independent adjustment takes but a few seconds.




Tape Deck : ZX-9/Tape : ZX(Metal)/PB Eq : 70μs

ZX-9 Frequency Response and Noise Analysis



# A Transport Unlike Any Other

## In Conception, Implementation, And Operation, The Nakamichi Asymmetrical Dual-Capstan, Diffused-Resonance Transport Is Truly Unique.

**Why are Nakamichi transports constructed of plastic and aluminum? Isn't steel better?**
No, it isn't! Tape behaves like a string under tension. As it passes the heads, vibration causes "scrape flutter" and "modulation noise" — a prime cause of "muddy sound." Such problems can originate from gear, capstan-, and reel-motor vibration if the chassis transmits it to the tape. Our chassis materials are specially chosen and treated to absorb vibration *before* it affects tape motion. The trasport is considerably more expensive to manufacture, but we believe better sound is worth the expense.

**What else causes scrape flutter?**
The pressure pad, and our transports are unique in not requiring one to maintain tape-to-head contact. As the heads move into position, a special lifter forces the pad out of contact.

**How is tape-to-head contact maintained?**
By an extraordinarily accurate dual-capstan drive. Until Nakamichi developed the Asymmetrical, Dual-Capstan Transport, it was not possible to eliminate the pressure pad, and, to date, no one has been able to duplicate our achievement. Other single- and dual-capstan decks still rely upon the pad and are at the mercy of the cassette's mechanical precision.

**What are the advantages of the Asymmetrical Dual-Capstan Diffused-Resonance Transport?**
A dual-capstan drive isolates the tape as it passes the heads from variations in supply and takeup tension by capturing it between *two* capstan/pinch roller assemblies. Conventional dual-capstan transports employ identical capstans rotating at the same rate. Common-mode resonances are created concentrating wow at certain frequencies. It is not unusual for a well designed single-capstan transport to outperform a conventional dual-capstan one!

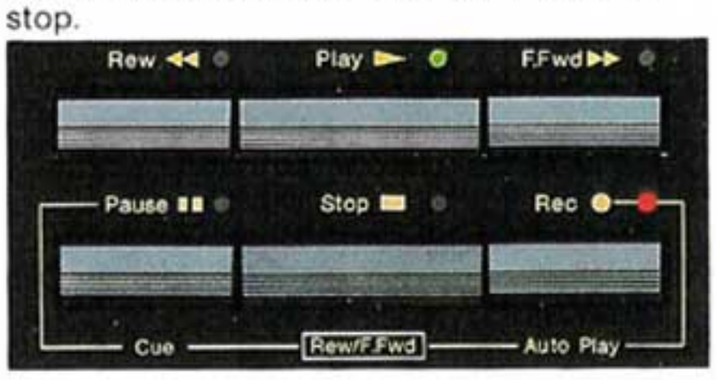
The ZX-9 transport employs different diameter capstans that rotate at different rates and thus eliminate common-mode resonance. Our flywheels also have different moments of inertia. This "asymmetrical" design produces a sound clarity beyond what the specs might suggest.

**What are the other special characteristics of Nakamichi transports.**
Our unique Motor-Driven Cam and microprocessor control! The solenoids used in all other electrically operated transports produce a jarring motion that can upset head alignment. They generate heat (which reduces reliability) and have only two positions — fully extended or fully released. There is no "in between."

Mechanism-Control Micro Processor

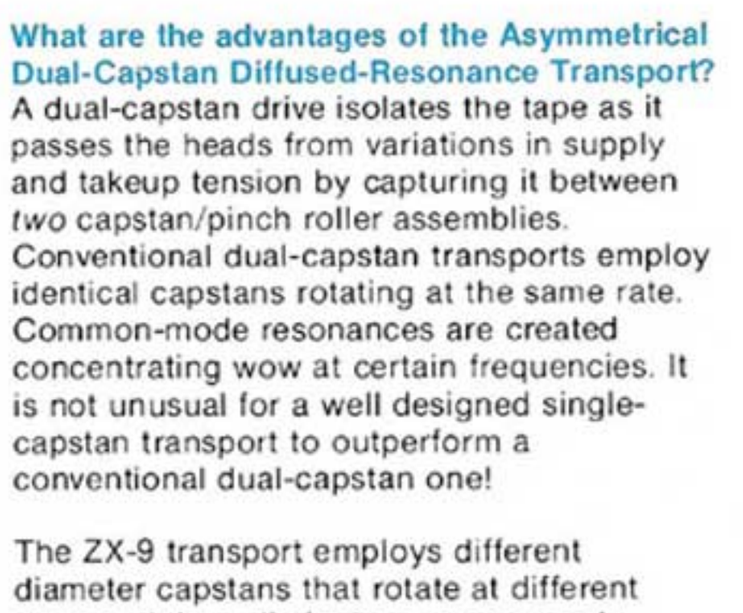
In our transports, a unique Motor-Driven Cam smoothly performs each mechanical function. Except when changing modes, the motor consumes no power and generates no heat. A 4-bit microprocessor controls the motor via two-way communications! a potentiometer driven by the motor tells the microprocessor what the motor is doing! the microprocessor tells the motor what to do next — 400 times per second! The system is extremely rapid and extraordinarily gentle. For example, the microprocessor can instruct the motor to bring the head assembly into position rapidly, then slow down and ease into place — a feat not possible with any solenoid!

Motor control also provides unusual features like Easy Cue. In fast forward or rewind, PAUSE slows speed to 1/3 and engages heads so you can monitor the tape. Holding either fast mode button then drops speed to 1/6. Rock between the modes to find the exact start of a program and press both to stop.

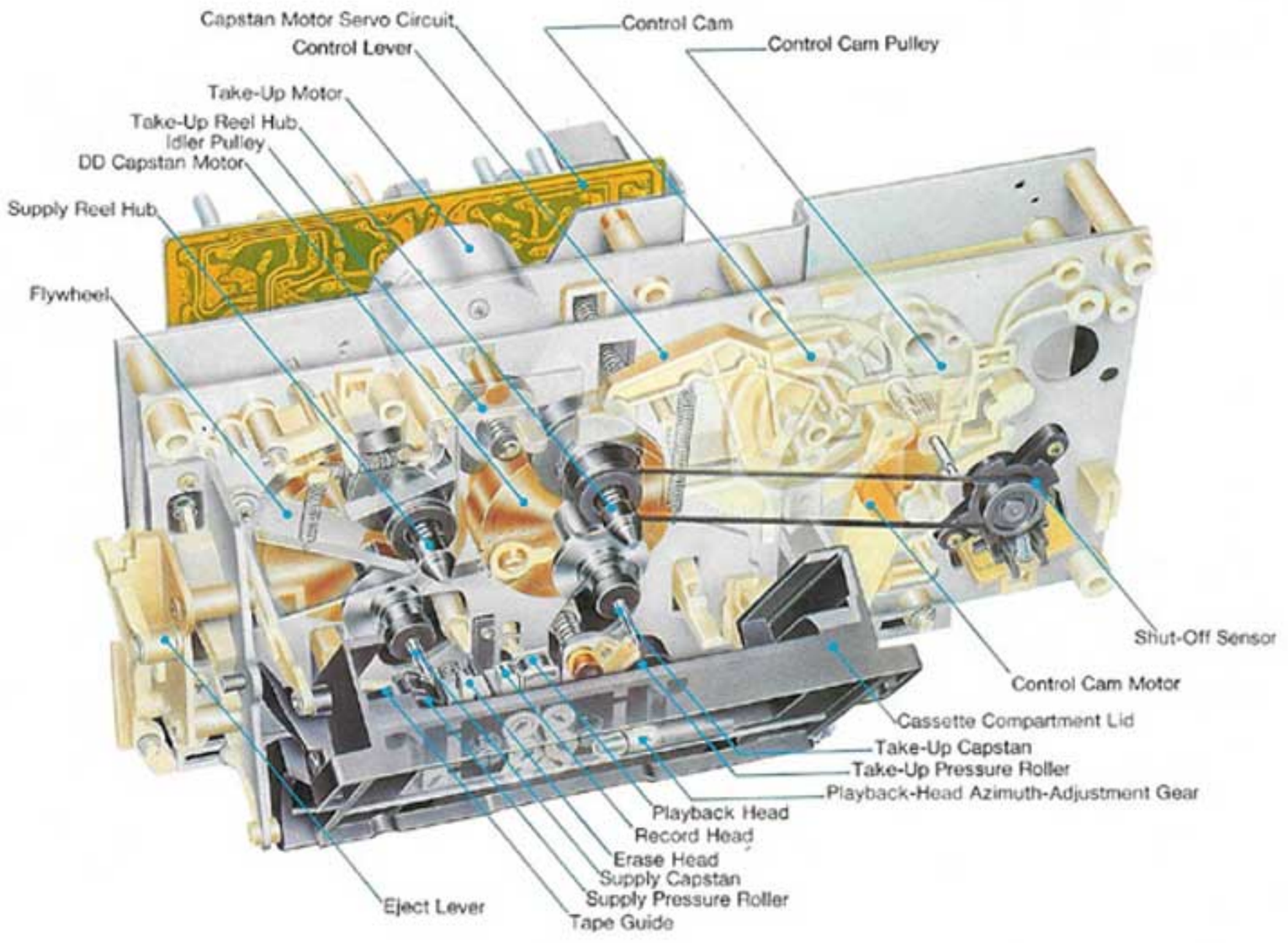



The microprocessor is programmed for Auto Playback and Punch-In Recording. Pressing RECORD and either FAST FORWARD or REWIND causes the tape to shuttle to "0000" and commence playback from that point. Pressing RECORD and PLAY simultaneously switches from playback to record for "flying-starts." These commands are accessible remotely via the RM-200 option.

Pressing REC MUTE records a blank section for as long as the button is depressed. The ZX-9 also features unattended recording and playback via any accessory timer.




Direct-Drive Dual-Capstan Configulation




Transport Mechanism Construction Diagram

# The Culmination Of Three Decades

## For Over Thirty Years, Nakamichi Has Created Advanced Tape Recorders, The Fruit Of This Experience Is Evident In Our Unique Head And Amplifier Technology.

**Are Nakamichi heads different from others?**
Yes, indeed! We have over 30-years experience in this specialized field. We developed the first three-head cassette recorder and, for many years, were the only manufacturer with a monitoring cassette deck. Now, there are many "three-head" decks, but ours are different.

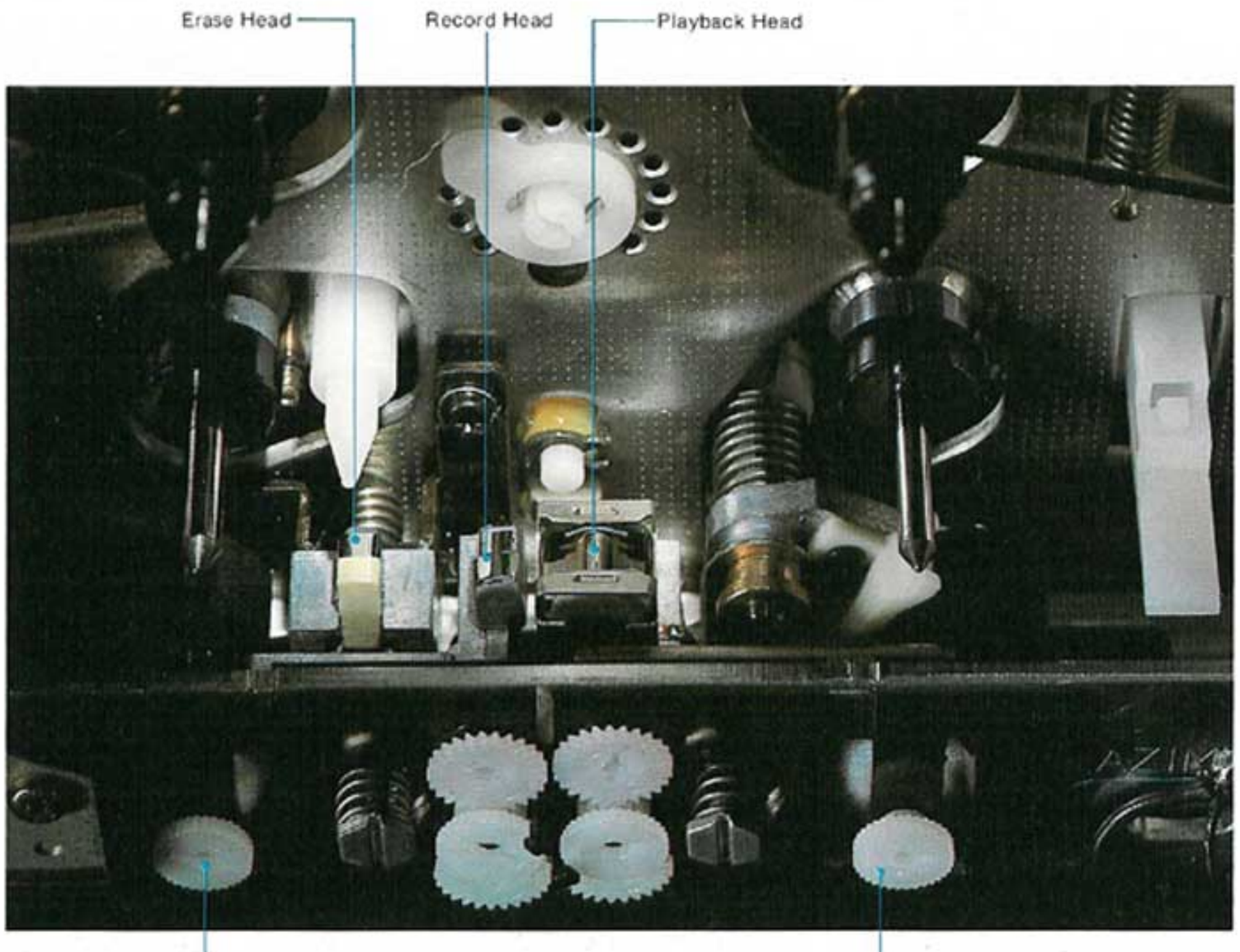
**How is a Nakamichi 3-head deck different?**
In many ways, the most obvious being our "Discrete Three-Head Technology?" Others use "sandwich" heads with record and play sections in a common housing. This increases crosstalk and bias feedthrough and presents grave problems in contouring the head for smooth response and proper tape-to-head contact. Most importantly, there is no way to adjust relative azimuth between sections. You may have heard that such heads do not need alignment, but such is not the case if perfection is the goal. One cannot assure *perfect* azimuth alignment without adjustment *in the recorder*. Ideally, the adjustment should be performed on every cassette since tape path differs slightly in each. Thus, the ZX-9 employs *physically* independent record and play heads with a means for you to adjust azimuth.

Our playback gap is much narrower than average — 0.6 micron or less than a wavelength of red light! — to provide exceptionally good high-frequency response.

Our recording gap is much wider — 3.5 microns — so that the field penetrates the entire magnetic layer and produces maximum low- and mid-frequency headroom. Our heads are individually shielded and specially contoured to eliminate so-called "head bumps" — the ragged low frequency response typical of most cassette decks.

**What about "wear?"**
The trend today is to physically hard core materials to reduce wear. Unfortunately, physically hard materials like ferrite are also *magnetically* hard; they have low permeability and high coercivity which increases the likelihood of head magnetization, reduces sensitivity, and increases noise. Ferrites also have low saturation induction; they saturate more readily and thus limit recording headroom.

Our "Crystalloy" material emphasizes *magnetic* properties. While physically not so hard as ferrite, it has extremely low coercivity and very high permeability and saturation induction making it ideal for record and playback heads. We solved the wear problem by special geometric design that ensures uniform wear. Our heads respond within 1 dB of spec after 10,000 hours of use. That's 3 hours a day, 365 days a year, for 9 years! We think that's adequate and see no reason to sacrifice sound quality for life!




**Do superior heads require better electronics?**
Yes, if the electronics are not to be the limiting factor. It is foolish to spoil the extraordinary performance of superior heads with mediocre circuitry. Because our heads have exceptionally wide dynamic range and extraordinaily broad frequency response, we pay special attention to electronic design.

**What are the most important factors?**
For the playback preamplifier, low noise, precise equalization, and wide dynamic range; for the recording amplifier, sufficient headroom and correct equalization, and, of course, a low-distortion bias oscillator.

**What is special about ZX-9 electronics?**
Directly coupled record and play heads with no capacitors to degrade sound quality; double-NF record and monitor amplifiers for superior stability; a pure-DC playback circuit that is extraordinarily stable and distortion free; and, a balanced bias oscillator for minimum distortion. Head-gap loss is compensated in the playback electronics in accordance with international standards to ensure compatibility with other properly designed decks.

**What is the purpose of the Master Fader?**
The Master Fader creates smooth professional fades at a touch! After recording level and balance are set, tapping the left side lowers recording level to zero; tapping the right raises it to full. Both channels remain in balance throughout the fade. You have a choice of fade rate — 6 seconds if you tap the bar, 2 seconds if you hold it depressed.

**Are LED meters sufficiently accurate for precise bias and record-level calibration?**
These are! Normally, the 16 segments span 50 dB (−40 dB to +10 dB) and respond instantly to the wide dynamics of modern program material, but, in the calibration mode, sensitivity automatically increases for precise resolution.

**What is the range of the tape counter?**
From "−999" to "9999", and when Memory or Auto Playback is commanded, tape stops *precisely* at "0000" from either fast mode.

**Features**

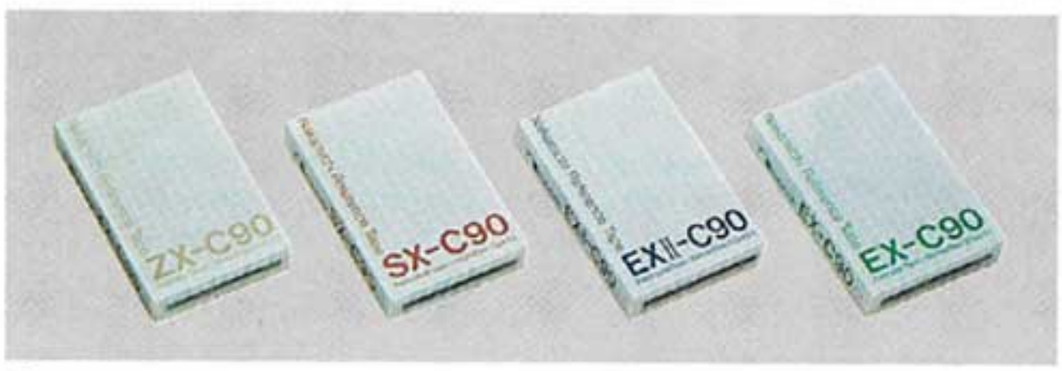
- Super Linear Torque Direct-Drive Capstan Motor
- Asymmetrical, Dual-Capstan, Diffused-Resonance Transport On Non-Resonant Chassis With Motor-Driven Cam, Dual Slot Guides, And Tape-Pad Lifter
- 4-Bit N-MOS Microprocesor Control With 2-Speed Cueing, Cue "Rocking," Automatic Playback, Punch-In Recording, Rec, Mute, High-Speed Shutoff, and Slack-Tape Takeup
- Azimuth-Alignment Control With LED Phase-Detecting Indicator
- Individual Bias And Record-Level Calibration Controls For Each Channel And Tape Type
- Auto Rewind After Calibration Via Calibration-Reset Button
- Separate Tape And Equalization Switches for ZX, SX, And EX Tapes
- Discrete 3-Head Technology With 20 –21,000 Hz ±3dB Response
- Dual-Gap Ferrite/Sendust Erase Head For Low-Noise Erasure Of Metal Tape
- Laminated Crystalloy Record And Playback Heads For Low-Distortion
- Double Dolby-B And Dolby-C Noise Reduction With Defeatable MPX Filter And Full Off-Tape Monitoring
- Individual Left And Right Input-Level Controls
- Automated Fade-Up/Fade-Down With Choice Of Fade Rate
- Direct-Coupled Record And Playback Amplifiers
- 50dB Peak-Responding Electronic LED Metering
- Output Level Control
- High-Output Headphone Jack Plus DC Power For Blackbox Series
- 4-Digit LED Electronic Counter (–999 to 9999) With Tape-Start Memory
- Unattended Operation In Record Or Playback Via Accessory Timer
- Total Remote Control Via RM-200 Option

SP-7 Stereo Headphones

**ZX-9 Specifications**

| | |
|---|---|
| Track Configuration | 4 tracks/2-channel stereo |
| Heads | 3 (erase head x 1, record head x 1, playback head x 1) |
| Motors (Tape Transport) | FG servo, brushless, coreless, Super Linear Torque DD motor (capstan drive) x 1<br>DC motor (reel drive ) x 1 |
| Power Source | 100, 120, 120/220-240, 220 or 240V; 50/60 Hz (according to country of sale) |
| Power Consumption | 50 W Max. |
| Tape Speed | 1-7/8 ips. (4.8 cm/s) ±0.5% |
| Wow and Flutter | Less than ± 0.045% WTD Peak<br>Less than 0.022% WTD RMS |
| Frequency Response | 20-21,000 Hz ±3 dB (at –20 dB, ZX tape)<br>20-20,000 Hz ±3 dB (at –20 dB, SX/EXII tape) |
| Signal-to-Noise Ratio | **Dolby-C Type NR on** <70μs, ZX tape><br>Better than 72 dB (400Hz, 3% THD, IHF A-WTD RMS)<br>**Dolby B-Type NR on** <70μs, ZX tape><br>Better than 66dB (400Hz, 3% THD, IHF A-WTD RMS) |
| Total Harmonic Distortion | Less than 0.8% (400 Hz, 0 dB ZX tape)<br>Less than 1.0% (400 Hz, 0 dB SX/EXII tape) |
| Erasure | Better than 60 dB (100 Hz, 0 dB) |
| Separation | Better than 37 dB (1 kHz, 0 dB) |
| Crosstalk | Better than 60 dB (1 kHz, 0 dB) |
| Bias Frequency | 105 kHz |
| Input (Line) | 50 mV, 70k ohms |
| Output (Line) | 1 V (400 Hz, 0 dB, output control at max.), 2.2k ohms |
| (Headphone) | 45 mW (400 Hz, 0 dB, output control at max.), 8 ohms |
| BlackBox Series DC Output | ±10 V, 125 mA max. |
| Dimensions | 450(W) x 135(H) x 300(D) millimeters<br>17-3/4(W) x 5-5/16(H) x 11-13/16(D) inches |
| Approximate Weight | 9.5 kg, 21 lb. |

- Specifications and appearance subject to change for further improvement without notice.
- Dolby NR under license from Dolby Laboratories Licensing Corporation.
- The word "DOLBY" and the Double-D Symbol are trademarks of Dolby Laboratories Licensing Corporation.




**Tape**

ZX Metalloy Cassette Tape
(70 μs, metal bias)
ZX C-60 ZX C-90

SX Ferricobalt Cassette Tape
(70 μs, $CrO_2$ bias)
SX C-60 SX C-90

EX II Ferricrystal Cassette Tape
(120 μs, normal bias)
EX II C-60 EX II C-90

EX Ferrioxide Cassette Tape
(120 μs, normal bias)
EX C-60 EX C-90

RM-200 Remote Control

DM-10 Head Demagnetizer

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